Characteristics of Cell Wall Polysaccharides Isolated From Different Cell Types of Grain Sorghum

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Introduction

The high levels of potential energy in cell walls of forages are under utilized by ruminants, especially those requiring high energy inputs such as dairy cows. For grasses this poor utilization is partially due to the cross-linking of the wall components, particularly the attachment of polysaccharides to lignin. Model studies have shown that degradation of wall polysaccharides are not uniformly affected by increasing levels of lignin. Arabinoxylans are more resistant to degradation and those that are degraded tend to end up as oligosaccharides. We were interested in the degradation characteristics of different cell types isolated from grain sorghum, particularly why pith cell walls were apparently more resistant to degradation than vascular bundle cells or sclerenchyma cells (Wilson et al. 1993). This work was undertaken to evaluate differences in the types and quantity of structural polysaccharides isolated from walls of different sorghum stem cell types.

Material and Methods

Cell walls were isolated, using a modified Theander procedure, from different cell types separated from the fifth stem internode of plants at anthesis. Walls were subjected to a sequential chemical fractionation consisting of ammonium oxalate, delignification with sodium chlorite, hot water extraction, and stepwise increases in KOH (0.25M, 0.5M, 1.0M to 4.0M). Isolated fractions were analyzed for neutral sugar composition following 2N TFA hydrolysis.

Results and Discussion

Fractionation of the different cell wall types from sorghum stems into principal polysaccharide groups did not differ appreciably from each other even though they have different structural and functional roles. Table 1 shows that all of the different cell wall types resulted in similar amounts of total carbohydrate in each of the main groups of structural polysaccharides (pectic and hemicellulosic polysaccharides and cellulose residue). Pectic polysaccharides are defined here as all polysaccharides solubilized by ammonium oxalate, then sodium chlorite delignification, and lastly by a hot water extract. Hemicellulosics are those polysaccharides solubilized by KOH treatment, and the cellulose residue is what remains.

Neutral sugar composition of the different fractions varied little among the different cell wall types (Figs. 1 and 2). Delignification of walls typically solubilizes additional pectic type polysaccharides in legumes such as alfalfa; however, in these grass walls the major polysaccharide released would belong to the xylan group (Fig. 1). Pith cells have a wider distribution of neutral sugars in most of the polysaccharide fractions. This is most likely due to the lack of extensive secondary wall thickening that is seen in the other three types of cells, leaving the primary wall as a larger proportion of the total wall structure. The other cell wall types are more homogeneous in terms of sugar composition, suggesting that the secondary wall thickening of these cells are all similar.

Conclusion

Although the cell walls surrounding the different sorghum cell types appear anatomically different, polysaccharide composition appears to be quite similar. Degradation differences among these cell walls, particularly the less digestible pith walls, would not seem to be attributable to significant differences in structural polysaccharides. Instead it suggests that differences in pith wall digestibility may be due to increased cross-links among the different wall components.

Reference

Wilson, J.R, D.R. Mertens and R.D. Hatfield. 1993. Digestion, cell wall and anatomical characteristics. 63:407-417.

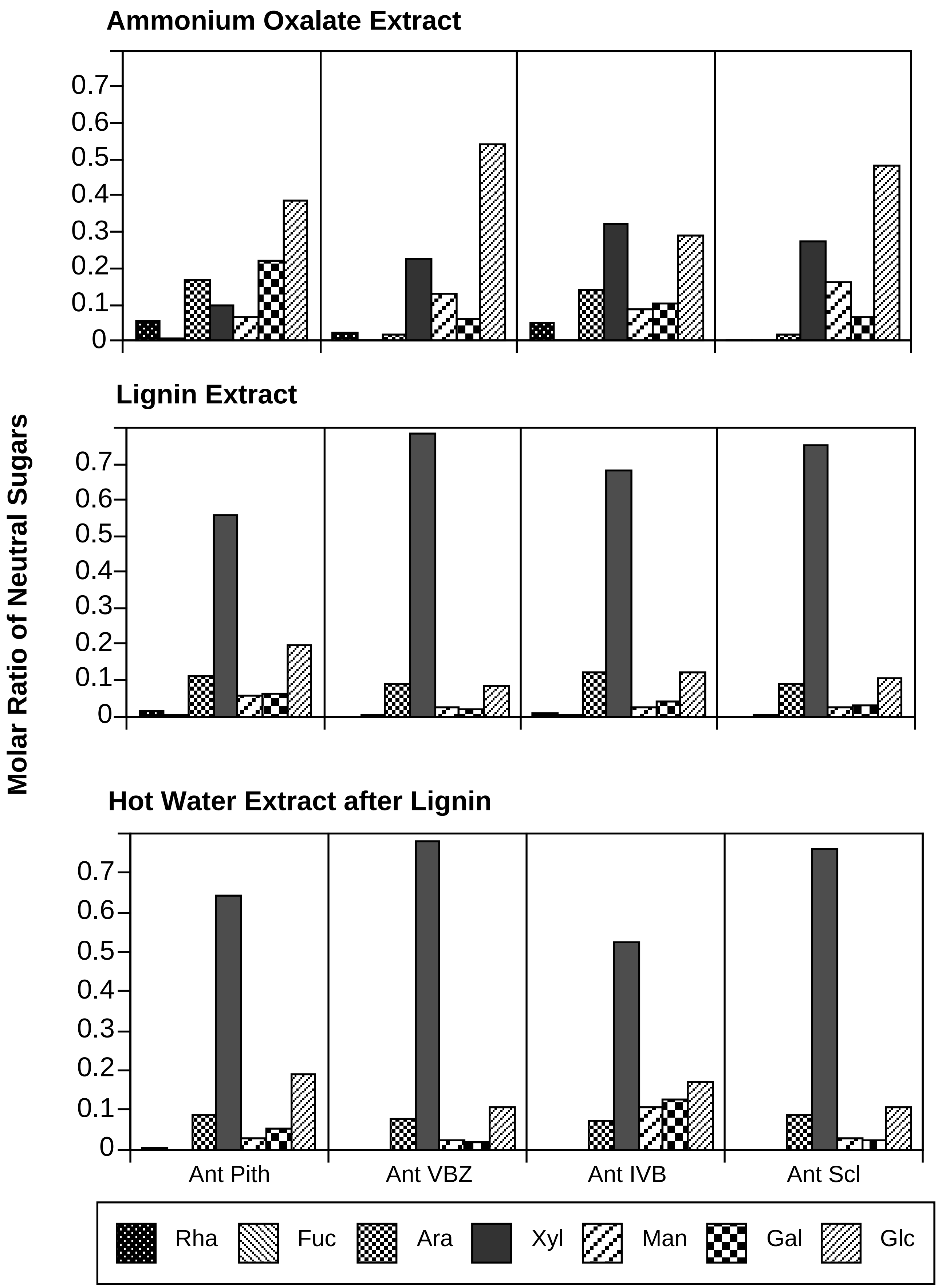

Figure 1. Neutral sugar composition of structural polysaccharides isolated by ammonium oxalate, sodium chlorite delignification, and hot water extraction after delignification.

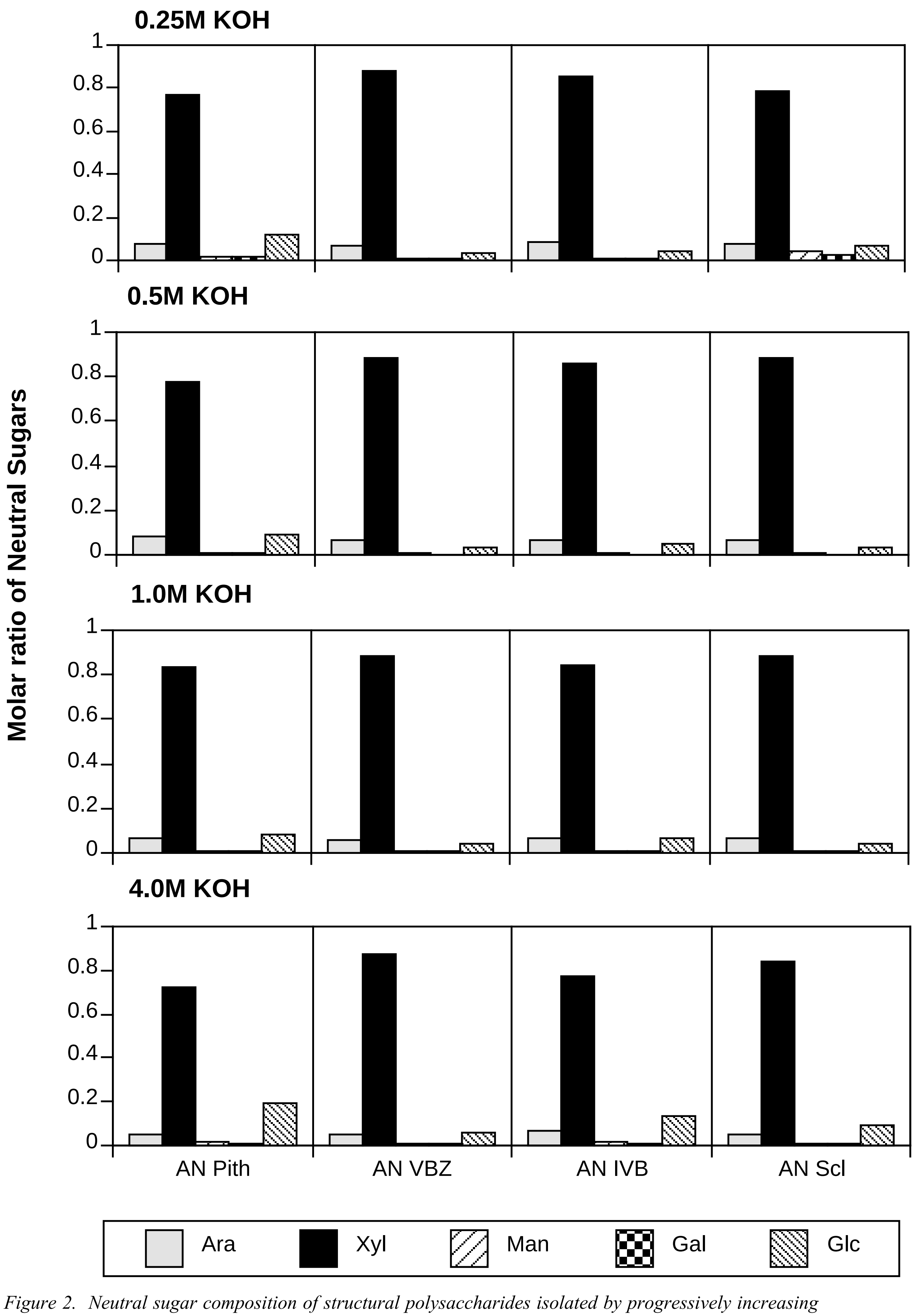

Figure 2. Neutral sugar composition of structural polysaccharides isolated by progressively increasing concentrations of KOH.

Table 1. Recovery of total carbohydrate in each of the major polysaccharide groups from the wall fractionation procedure. AN = anthesis; Pith = pith cells; VBZ = vascular bundle zone cells; IVB = inner vascular bundles, SCL = sclerenchyma.

	g/g CW			
Cell Type	Pectic ext.	KOH ext.	Cellulose	Lignin
AN Pith	0.030	0.330	0.396	0.128
AN VBZ	0.031	0.284	0.459	0.181
AN IVB	0.039	0.354	0.416	0.161
AN SCL	0.040	0.292	0.423	0.132